MACHINE HOUR RATE METHOD
OF
DISTRIBUTION OF FACTORY INDIRECT EXPENSE

BY

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ARMOUR INSTITUTE OF TECHNOLOGY

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THE MACHINE HOUR RATE METHOD OF DISTRIBUTION OF FACTORY INDIRECT EXPENSE

A THESIS

PRESENTED BY

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TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

MECHANICAL ENGINEER

MAY 29, 1918

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INTRODUCTION.

This thesis consists of two sections, first a discussion of the several methods of distributing factory indirect expense, called also burden, loading or over-head, the second part being a statement of conditions, and the actual application of the machine hour rate method of taking care of the indirect expenses in a large manufacturing plant.

Included in the second part are; some of the instructions issued to the factory, the machine classification, accounting instructions, forms and descriptions written by the author, for use in the departments interested, to assist in getting the method into use. While some of the material may not be directly applicable to other plants, it is believed that a detailed description of the problem as a whole will be of interest and assistance to any one who might be required to apply the method, as well as

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to engineers in general, as the engineer's field of work is constantly coming closer to the field of management.

The author is an engineer, hence this thesis is written from the technical rather than the accounting standpoint, but the aim was constantly kept in mind to harmonize to the greatest possible degree the view points and practical requirements of both shop and office.

THE THEORY AND APPLICATION OF THE MACHINE HOUR RATE METHOD OF DISTRIBUTING FACTORY INDIRECT EXPENSE.

-: Part One :-

The work of the engineer, especially the one who is connected with factory work, is constantly broadening, and embracing more of the field of management. To be sure, there are many who will confine their work to purely professional lines, but industrial management requires the trained mind of the engineer, applied to management and business problems almost as much as to technical problems. One of the principal things with which the engineer must be at least somewhat familiar is factory and construction costs.

The life and death of most manufacturing concerns depends to a large extent on their cost systems, how well they perform their duties and how the facts they bring out are made use of. It is, of course, self evident, that factories are run for the purpose of earn-

ing money, and if they don't do it, they can not remain in business very long. To earn money, the goods which are produced by the factory must be sold for more than they cost, hence to know the selling price, the cost must be known. The accuracy with which the selling price is fixed is a direct function of the accuracy of the costs, except in the case of certain monopolies and patented articles, and even in the latter cases, to know what the earnings are, the costs must be known. Thus it will be seen that factory costs are very important, and are among the principal items which must be closely watched by the management. This is summed up very well by C. R. Thompson in his book on Factory Costs,- "An accurate cost system faithfully reflects the changes, not only in the cost of materials and labor, but in the efficiency of operation and management from one period to another. It is, therefore, a valuable guide to the manager,

directing him where and when to apply his particular attention to these details."

The object of cost accounting is to charge each unit of the production with its share of the production cost, so that every element going into this expense will be absorbed in the selling price. There are three principal divisions of the manufacturing costs, which are labor, material and indirect expense, (also spoken of as burden, loading or over-head) The labor and material can usually be readily figured, but the indirect expense is made up of so many items, some of which are indeterminate, that the accurate determination of the total amount is difficult. The method of distribution to the product brings in another variable, since the different methods of assigning the indirect expense will give, in many cases, different manufacturing costs on the same article. Thus the necessity of careful analysis and study of conditions in a given plant will be evident.

The indirect expense is made up of charges for factory administration, general administration, indirect or so called nonproductive labor, light, heat, power, expense supplies such as waste, oil, tools, belting, etc., maintenance and despreciation on buildings and equipment, and in some cases rent and interest on the investment. It includes in fact all the expenditures which are not included under the heads of labor, material or Capital Account, i. e., expenditures involving additional plant value. The depreciation charge cannot be definitely determined, as there are so many indefinite and changing factors entering into it and at best it can only be estimated as accurately as possible from the data based on previous experience.

All that can be expected of the best cost system is a fairly accurate approximation, and the accuracy of results obtained depends on how detailed and careful an analysis has been

made of the elements which go to make up the cost and the method in which they are combined and distributed for a final result. There are several methods of distributing the indirect expense of the product, the principal ones of which are percentage of direct labor, a charge on labor hours, charge per pound, or other unit, and the machine-hour-rate method. In the first method, the expense is distributed either by means of a departmental percentage on the cost of productive labor or in some places a percentage covering the total productive pay-roll for the plant; in the second method, the expense is divided up on the basis of labor hours and in the third spread over the product directly. The machine-hour-rate method, which is herein described, distributes the expense by means of an hourly rate for each productive machine, which is based as nearly as possible on the actual operating expense of the machine, plus charges

for the other indirect expenses, such as administration, depreciation, building charge, etc., pro-rated among the machines on the most logical basis for each item. The first method, or percentage of direct labor cost is the one most generally used, because it is easy of application and in many cases is sufficiently accurate for all requirements. The second and third methods are used to a certain extent, while the fourth method or machine-hour-rate plan of distribution, though not so widely used, is coming into use more and more among progressive concerns. With the increase in competition and corresponding close margins in pricesm, which are sure to come after the war, the machine-hour-rate method, being the most accurate of the four, where it applies, will come into still more extensive use. In deciding which method will be used, the nature of the product must be considered as well as other conditions in the factory, for example in a

paper mill, making one general line of product, it may be much more satisfactory to distibute the over-head on a basis of pounds of paper made, or a plant turning out but few lines of product and equipped with machines of practically the same type, could use either a rate per pound, or percentage of direct labor or charge per labor hour with equal satisfaction. However, in a factory having a large variety of machines and equipment, which will have very different operating expenses, the most accurate way of figuring cost is by the machine-hour-rate method.

After labor and material are taken care of, the first requirement for any method of distribution of indirect expense is the determination of the amount to be distributed. Salaries and indirect labor can be obtained from the pay-roll; expense supplies and other expenses can be obtained from requisitions, vouchers and bills, after these have been

properly classified. Depreciation on buildings and equipment is usually figured in accordance with standard practice, with modifications to fit special conditions, and is assumed to be correct, until shown otherwise by experience.

Assuming now that the amount of over-head is known, and that an analysis of conditions indicates that the machine rate method is the most suitable for distributing this amount to the product, we will proceed with the further study of the machine-rate method.

The machine-hour-rate plan requires the collection of all factory indirect expense into an hourly charge against the product going through the machine, "machine" being taken to mean benches, furnaces used on the product and other equipment contributing directly to some productive process, as well as true machines. Each machine, or

group of machines which are of the same type, and near enough the same size to have the same rate, is treated as a production center, for use of which the product pays a charge, similar to rent, based on the rate and number of hours it occupies the machine or center. Thus the product of rate and hours for a given period of time, gives the amount of burden earned by the machine to be credited to its share of the total indirect expense.

The machine rate is made up of three classes of charges,- (1) the operating charges which can be easily allocated to the machines, (2) the building charge, and (3) the administration charge. The operating rate includes cleaning and oiling, depreciation, maintenance and repairs, power, special lighting, tools, and supplies. The different factors entering into the operating cost require analysis to be sure that the true cost is used. For example, the electric power charge should include in addition

to the cost per kilowatt hour, the maintenance of the electrical distributing system, transformers, motor generators, electrician's labor, and electrical expense supplies. On machines driven by line shaft, the cost of maintenance, depreciation, etc., on this should be added to the cost of power for the motor, and charged to the machines. A similar analysis is necessary for determining the cost of water, fuel oil, cutting compound, compressed air and steam, where these are used. In most plants some non-productive machines are necessary, which use power, but will not have a machine rate. A very satisfactory way to charge their power is to take the total department power charge and distribute it over the productive machines in the department, on the basis of kilowatt-hours used per month per machine. The same method will apply to the other items mentioned.

Each production center occupies a certain amount of space, for the use of which it

must pay its proportionate share of total building charges, including rent (if charged), taxes, depreciation, insurance, fire-protection, janitor service, maintenance and repair. There are several ways of dividing this expense among the machines, but the one which is easiest to apply, and is as accurate as any is to find the floor space occupied by each productive machine and operator by measurement, add these spaces to get a department total, and then use the ratio of machine floor space to department machine floor as a basis of division. This automatically takes care of department store or tool rooms, aisles, and space not used. In the case of stores departments serving the whole plant, the charge can be equitably spread over the departments on the basis of department productive machine floor space compared with total plant productive machine floor space. The building charge for non-productive and administrative departments may either be added to the store space

charge, and divided as above, or added to the administration charge, to be divided with the rest of the administration charges. There are often other charges which may conveniently be included in the building charge such as crane service, trucking and janitor service.

The administration cost covers the salaries of officers, superintendents and foremen, store keepers, inspectors, accountants, clerks and so on. It also includes supplies such as stationery and equipment used by them. The building cost for administrative departments may either be included here, or in the charge distributed to the departments with the storage space item, as mentioned before. Since a more accurate rate can be established if the indirect expenses are departmentalized as much as possible, it is advisable to divide administration into general and shop administration. The former will include plant office force, engineering department, president, secretary, treasurer,

general superintendent, factory manager and others whose services benefit the plant as a whole. The latter includes foremen, shop clerks, department indirect labor and department time keepers. The general administration expense may be apportioned to the departments on the basis of machine-hours compared with total machine-hours, of other department indirect expense compared with total other indirect expense, or of department rate-hours compared with plant rate-hours, the rate here being before the general administration is added. In a plant having a wide variety of equipment, the latter is the fairest method of distribution. Rate-hours will be in terms of dollar-hours, that is, the product of machine hours and machine hourly rate.

The current opinion seems to be that the machine hour rate method is very complicated and difficult of application, but there are in reality but two difficulties. The first is the

problem of getting into the rate every item that belongs there. These are very numerous, but starting with a familiarity with the plant and its operation, a careful analysis and study of the proposition should enable one who knows what is wanted, to gather them all together. Where fairly complete records are kept, the data can be obtained through the accounting department, time-keeping department, shop offices, and observation and tests in the plant. Provision should be made for adjustment to take care of items that might be omitted, and later discovered, or that may be changed by conditions in shop or business in general.

The second difficulty is in the disposition of the unearned burden because of idle time, that is, time when the machines should be in operation to earn their predetermined share of the operating expenses of the business, but are not. In nearly every manufacturing plant, it is necessary to have machines which are in

use only part of the time, even when the plant is working at normal capacity. To put into these rates all the charges that would ordinarily go into them would make an abnormally high rate. It would seem that this rate should be modified by distributing part of its charges to the other machines that are busy a high percentage of the time, but this is a question which must be decided by the management, taking into consideration the conditions, and effect on the price of work going through the machine. Some machines such as ordinary floor grinders, drill presses, or tool tempering furnaces are better treated as non-productive machines when they are used only occasionally, because they would have to carry a rate that would be out of proportion for the work they perform, and because of the difficulty of obtaining accurate reports of the hours occupied. Time which is idle for the reasons stated can be disposed of fairly easily in setting the rate, but idle time due to un-

expected interuptions to production through accident, lack of work, labor trouble, or lack of necessary supplies must be handled differently. In this case, there will be a deficit in the burden account, that is, the burden charges will not be completely written off as planned.

One way in which idle time deficit may be handled is to establish two rates for each machine, one which is called the machine rate, being the rate based on working the normal number of hours, and the other a supplementary rate, which is adjusted from month to month, or other accounting period, and added to the machine rate for the next period, or as long as necessary to completely balance the account for the machines in question. Idle time thus becomes a factory cost. Another way of handling the deficit is to add a percentage to the cost of all work going through the departments not carrying their burden, which also makes it a factory cost. A third method, when the idle time is due to not providing sufficient work

to keep the plant busy, is to charge the deficit to the business as a whole. This is the most correct way, since the function of the factory is to perform the work and not to make the sales or get the business. Another point to consider is that, allowing for small differences due to quantity, the true factory cost will not vary at the same rate as the apparent factory cost, if idle time is made a factory charge. Thus the manner in which this question is handled may make quite a difference in the business policy, and on prices quoted. Making this charge against the business brings out to the management very strongely the importance of keeping the plant well supplies with work.

After the total department indirect charges, including the share of the general plant and factory administration charges, have been determined, these must be distributed to the productive machines. It now becomes necessary to know the probable number of hours that the machines will operate for the next month

(or other period). This data can best be obtained from records of the past few months, if these are available. If no records have been kept, an estimate must be made, and proper provision made for keeping records of machine hours.

It will be best to separate the building charge and the administrative charges, and divide these among the machines in two different ways. The building charge is a function of the space occupied by the machine, so that it should be pro-rated on the basis of machine floor space. A simple way of handling this is to get a cost per square foot by summing up all department machine floor space, and using this figure as a divisor, into the total department building charge. The machine floor space multiplied by the rate per square foot gives the building charge for the machine. The shop administration charge should be divided on the basis of machine hours, since the machine which works the most

will require the most supervision. To obtain the figure for each machine, the division may be handled in a similar manner as the floor space, that is,- divide the shop administration charge for the department by the total estimated number of machine hours for the given period, which will give a rate per machine-hour, to cover the administration cost. With the machine operating cost determined, plus the building charge, we have the amount for the month or other period, to be divided by the machines hours for that period. This result added to the hourly administration charge mentioned above gives the machine-hour-rate for the factory expense. There is one more factor which must be added to obtain the final rate which will be used, and that is the general administration. This may be added as a percentage, which is worked out by comparing the total amount of the general administration cost with the total burden for the plant, and increasing the latter by the result-

ing ratio, or in one of the other ways previously mentioned. It may be more desirable in some plants to include the general with the shop administration, which is somewhat easier, but if the former is very large in proportion, is not as accurate.

In some plants, where orders are worked on that last for some time, or conditions are such that it will not be inconsistent with good management to get the costs at the end of each month, the machine rate plan furnishes the means of getting the most accurate distribution of burden of any of the methods used for the purpose. When this is the case, all the items entering into the burden except some of those which are not determined by expenditures from month to month, such as depreciation, can be summed up into one amount which is the known burden for the month. The actual number of machine-hours which were operated during the month can be determined from the time reports.

In this way, the element of uncertainty (in predicting the number of hours each machine will be occupied for the coming month) is eliminated by using records of actual performance. The expense material entering into the rate can also be accurately ascertained from t the requisitions for the month, which when properly classified can be allocated to the proper equipment. Thus the rate used is based on pre-determined amounts and not on preliminary estimates, making possible a very close balance between the burden earned (or accounted for by the machine-rate) and the expense for the month.

When the machine-rate method is first installed, the rate will probably need adjustment from month to month. It will be necessary to check over machine hours for each machine, to see how closely these approximate the estimated hours on which the rate was based, to see that each machine earns the burden it

is supposed to carry. To make the checking up as simple as possible, it would be advisable to develop forms and standard methods of collecting and handling the various items that make up the factory indirect expense. Where rates are found to be inaccurate or where conditions require them to be charged, provision should be made for making this adjustment. A good way of providing for this is to issue a sheet monthly or at some other definite period, giving the machine rate for each machine which is to cover that period and be in use until the next sheet,is issued, thus with the rates taken from the current sheet, the proper rate will always be in use.

Because of the importance of the time element in determining the amount of burden to charge, it is very necessary that whatever system is devised should be consistent with the method adopted by the time keeping department to avoid duplication of effort and to get the results in the simplest possible manner. The duties of the

timekeeping department and the cost department some-times over-lap, so that any plan that is adopted for keeping the time records should be consistent with the work of each department.

The determination of the amount of overhead expense to be charged to any job is very simple when the rate has once been set. It is necessary that three items be known, that is, the order number or name of the work, the number of hours the work occupied any of the production centers, and the number of the machines occupied. Hours multiplied by rate gives the amount of burden and this added to the direct cost of labor and material gives the factory cost of the work. It will be a good policy to open a burden account to keep track of the amount of burden through the application of the machine hour rate and the actual total amount of the burden as shown in the accounting records. If under conditions of normal operation the burden earned does not approximately equal the actual burden, some of the rates must be adjusted accordingly.

PART TWO.

THE APPLICATION OF THE MACHINE RATE METHOD.

Recently the ——Forgings Co. of Indiana, decided to apply the Machine-Hour-Rate Plan to their plant, and to the author of this paper was assigned the work of putting the plan into operation. The Company is engaged in making railroad car and locomotive axles, and other heavy forgings and doing the heat treating and rough machining on some of them. The plant is comprised of a steam hammer department, hydraulic press department, machine shop for making dies and forging tools, a heat treating department, machine shop for rough machining forgings, black-smith shop for making tongs, clamps and other accessories used in forging operations, carpenter and pattern shop, power plant, and office building. In the past few years, the plant has nearly doubled in size to take care of increased business, and has grown so rapidly that the organization could scarcely keep up

with the growth. This meant that the duties of those working for the company previous to its expansion, increased considerably to take care of the increased work to be done, in addition to absorbing and breaking in a large number of employees. The result was that every effort was made to increase production, and get the new additions into operation, letting efficiency, records and cost methods go for the time being, to a working minimum. This, under the circumstances was the most advisable course to pursue, but it complicated considerably the problem of getting things into shape after the desired production was approached and attention could be turned to it.

The problem of gathering up the loose ends, and carrying out the plans of management in regard to the method of distribution of the indirect plant expense briefly stated was,- to classify and group the plant equipment in order to establish production centers, each member of

which would do the same kind of work, and carry the same hourly rate; to provide for collecting the data necessary to determine total amounts under the heads of building charge, shop administration and general administration; to get the data for figuring the operation charges for each machine, and then to distribute all these to establish the desired result,- the machine hour rate for each productive machine.

As no definite written instructions had been issued to the shop in permanent or standardized form, it was decided that as the different steps were worked out, these would be written up as factory instructions, and issued to those interested and entitled to them. A copy of part of these instructions is included in this paper.

In classifying the machines, these had to be numbered all over again, as they had previously been numbered just as they were placed in the shop, and the new machines numbered in the order in which they were received. Thus number twelve might be a sensitive drill press, thirteen a heavy duty engine lathe, fourteen a power hack-

saw and so on, the numbers having no relation to each other or to the machines. Following a suggestion from the Manufacturing Instructions of one of the plants near Chicago using the Taylor system of scientific management, a numbering system was worked out, classifying the machines by functions, types and sizes, so that similar machines would have similar numbers, and the numbers would mean something to those familiar with the plan. The use of the machine numbers for running order numbers for expense supplies and labor, and accounting classifications as explained in Section One of the Factory Instructions, was an addition to the original numbering plan. It furnishes a simple way of collecting much necessary data, and means the elimination of considerable work, confusion and chances of error The detailed working out of the machine classification is given in Section Two, which will illustrate this method of machine numbering. The numbers were painted on the

machines, and later will be stamped on metal tags and attached to them.

In addition to the numbers assigned to the machines, the different piping systems, electrical distributing system, line shaft units, etc., were given numbers for the purpose of furnishing running order numbers to assist in establishing the net cost to the company of steam, compressed air, electrical power, and the like. The list of these with their descriptive notes, given in Section Three, will be self explanatory.

Following the plan previously used, it was decided that the factory costs would be figured monthly as before. Because of the nature of the work, turned out by the plant, this is a satisfactory policy, and as it effects the burden distribution problem, is quite an advantage. By establishing the rate at the end of the month, it is practically the distribution of known amounts, so that the burden as spread to the product should balance very closely with actual ex-

penditures not accounted for by direct labor and material, and items chargeable to plant account, excluding depreciation on plant and equipment.

The running order number scheme is an expansion and broader application of a system previously in use to a limited extent, combined with the machine classification plan, for the purpose of collecting and classifying the charges for maintenance and repair of the plant equipment and buildings, including both labor and materials coming under these heads.

To show how the labor charges are obtained, an explanation of the time-keeping plan will be necessary. All the factory employees except those on the monthly roll (foremen, master mechanics, superintendents, etc.) report their time on cards, one side of which is printed for stamping the time of coming in and going out, by the time clock, and the other side printed to provide spaces for reporting the

job number and nature of work done, number of hours on each job, and the nature of the machine worked on. These cards are collected daily, and sent to the time office, after being checked by the shop clerk to see that each man turns in his card with all the information required. The job numbers for new construction, production, repair and maintenance work are all distinctive, so that there will be no duplication of numbers and no difficulty in deciding what the work is in the cost department. Any work on repairs, maintenance, expense tools, or other items included in the burden, is assigned a job number by the shop office taken from the list of running order numbers, or if not found there, from the number of the machine or production center involved. The time keeping department then distributes the labor charge as shown on the cards, under the proper order numbers, by departments. Thus the monthly expense labor charge is obtained, properly classified for

distribution into the items making up the machrates. This information, together with the productive labor is summed up, giving the amount of money expended for labor in each department for each job.

Requisitions for expense supplies, that is, those which are part of the burden, are handled in a similar manner. The same order numbers are used on requisitions turned into the store room, when materials are drawn out, and these are sent to the cost department to be grouped by number and totaled. In this way a large part of the indirect expense is obtained with the minimum amount of labor, It is assumed that expense supplies from the stores department are used as drawn out, so that the month's requisitions represent the consumption for that period.

The tool making department is treated as a productive one, the machines being given hourly rates, which are added to the charges for labor and material, the total being taken as the cost

of the tool or other work produced, even though it is a repair part. It may seem at first that in this way, some of the burden will be charged twice, since the costs of the tools and repairs go into the loading rates of the machines they are for. However, this way of handling the charges is correct, because the rate of each machine is computed by dividing its share of the burden by the number of hours it's in use, and if some work is done (as repairs) and the loading rate not charged, there will be a deficit for the machines so treated. This deficit would then have to be made up by increasing the rates of the machines for hours worked on the factory product, or spreading the deficit over all the machines. The net result would then be that the tool or repair cost would be less, and the balance of the rate greater by the same amount.

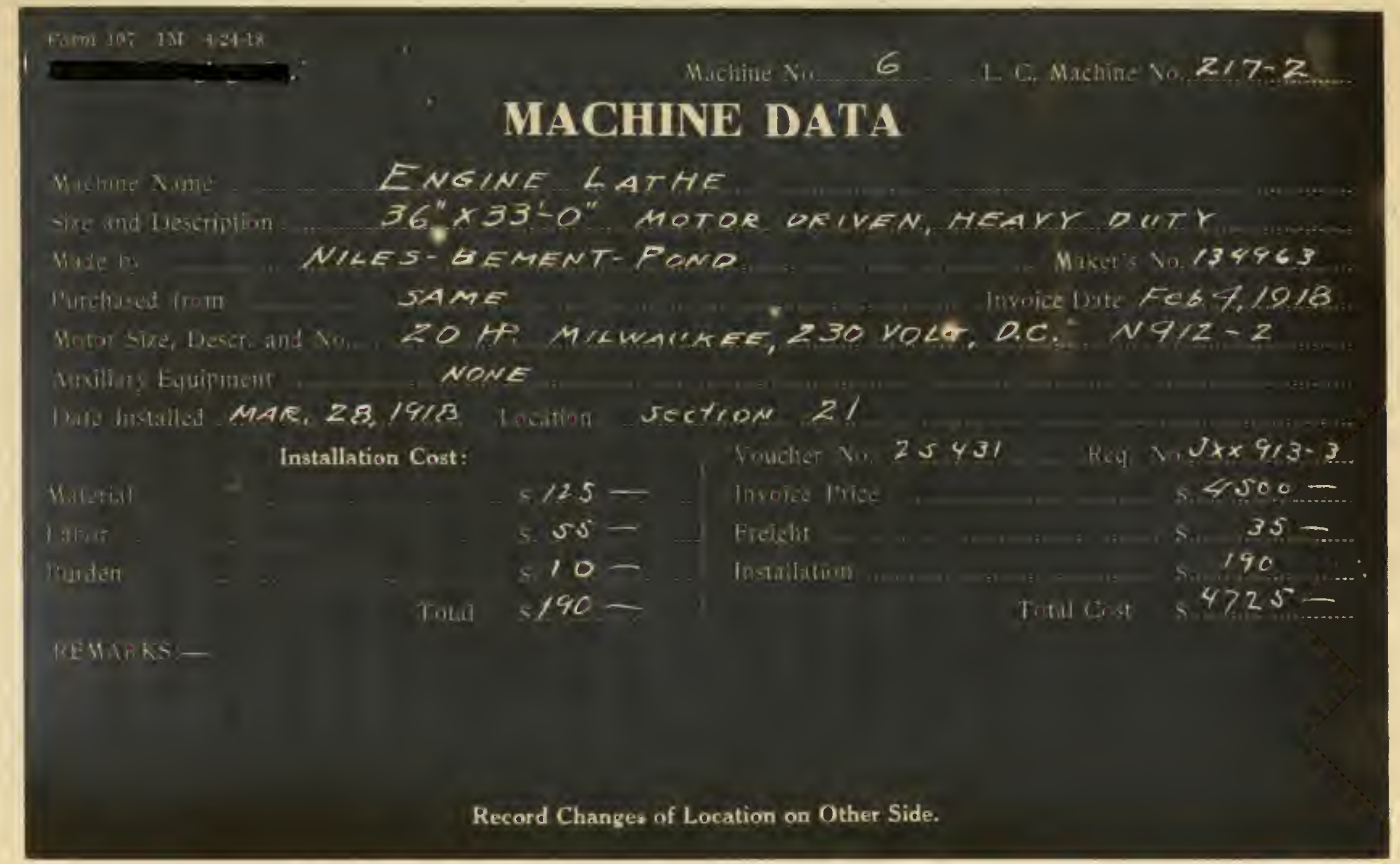
After getting the figures for maintenance and repairs from the time cards and requisitions, the remaining elements going into the

burden are,- administrative expense, indirect labor not otherwise disposed of, supplies not issued by the stores department such as coal and fuel oil, and the charges for water, purchased electrical power, insurance, taxes and depreciation. All of the above are charged to the departmental burden as far as practicable, the balance going into general administration and divided among the departments on the rate hour basis, which was discussed in Part One. Coal and fuel oil consumption are obtained by taking the amounts at the first of the month plus receipts, less inventory at the end of the month. Administrative salaries and indirect labor are obtained from the payroll, and electric power, water, taxes, and so on, from the bills rendered. Depreciation is figured from the cost of the machine plus installation charge, and the probable length of usefull service under the conditions of operation. The machines are used on heavy work and tough

material, in addition to being in use from eighteen to twenty-two hours per day. The rates of depreciation will therefore vary from fifteen to forty percent.

A portion of the equipment requires considerable auxiliary apparatus, for which rates will be established using the operating expense and building charges only. These will be then added to the rate of the principal machine, and its rate will include the administration charges for all, based on the total floor space.

It will be evident that in applying this expense distribution plan, there is a large amount of data that must be collected, tabulated, summarized and kept up to date. The principal heads under which this is collected are,- descriptive data on machines, including machine floor spaces per machine and department; machine hours and kilowatt-hours per machine; relative amounts of steam, coal, fuel oil, cutting compound, etc. per department or per machine per month, labor



Form 107 1M 4-24-18

[redacted]

Machine No. 6 L. C. Machine No. 217-2

MACHINE DATA

Machine Name ENGINE LATHE

Size and Description 36" X 33'-0" MOTOR DRIVEN, HEAVY DUTY

Made by NILES-BEMENT-POND Maker's No. 134963

Purchased from SAME Invoice Date Feb 7, 1918

Motor Size, Descr. and No. 20 HP. MILWAUKEE, 230 VOLT, D.C. N912-2

Auxiliary Equipment NONE

Date Installed MAR. 28, 1918 Location SECTION 21

Installation Cost:

Material	$ 125 —	Voucher No. 25431	Req. No. Jxx 913-3
Labor	$ 55 —	Invoice Price	$ 4500 —
Burden	$ 10 —	Freight	$ 35 —
Total	$ 190 —	Installation	$ 190
		Total Cost	$ 4725 —

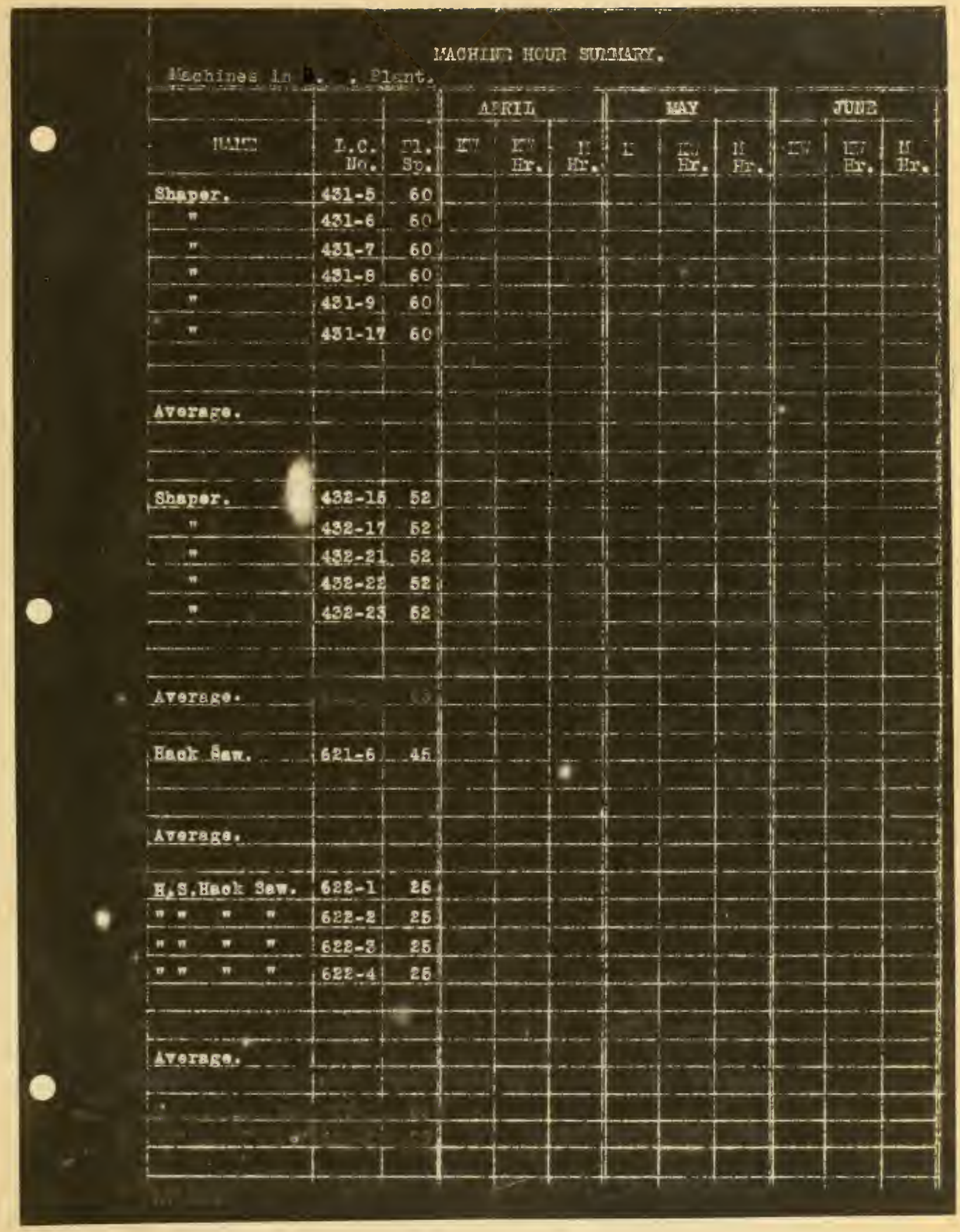
REMARKS—

Record Changes of Location on Other Side.

FIGURE 1.

and material included in the burden, collected by job numbers; machine repair records; administrative expense, divided into departmental, general administrative of plant, and general administrative for the business as whole. In addition there is a quantity of miscellaneous data necessary for determining the net cost to the company of electric current as used in the plant, steam, fuel oil, cutting compound, compressed air and water.

The descriptive data on the machines was obtained from the few records that were available and by going out in the shop and getting the balance. The form used for recording this information is shown in Figure 1, the "Machine Data" card. One of these was filled out for each piece of equipment coming under the machine classification. The floor space of each productive machine was taken as the number of square feet occupied by the machine plus the space used by the operator, and the total of the individual spaces thus measured,



MACHINE HOUR SUMMARY.

Machines in B. [illegible]. Plant.

			APRIL			MAY			JUNE		
NAME	L.C. No.	Fl. Sp.	KW	KW Hr.	M Hr.	KW	KW Hr.	M Hr.	KW	KW Hr.	M Hr.
Shaper.	431-5	60									
"	431-6	60									
"	431-7	60									
"	431-8	60									
"	431-9	60									
"	431-17	60									
Average.											
Shaper.	432-15	52									
"	432-17	52									
"	432-21	52									
"	432-22	52									
"	432-23	52									
Average.											
Hack Saw.	621-6	45									
Average.											
H.S.Hack Saw.	622-1	25									
" " " "	622-2	25									
" " " "	622-3	25									
" " " "	622-4	25									
Average.											

FIGURE 2.

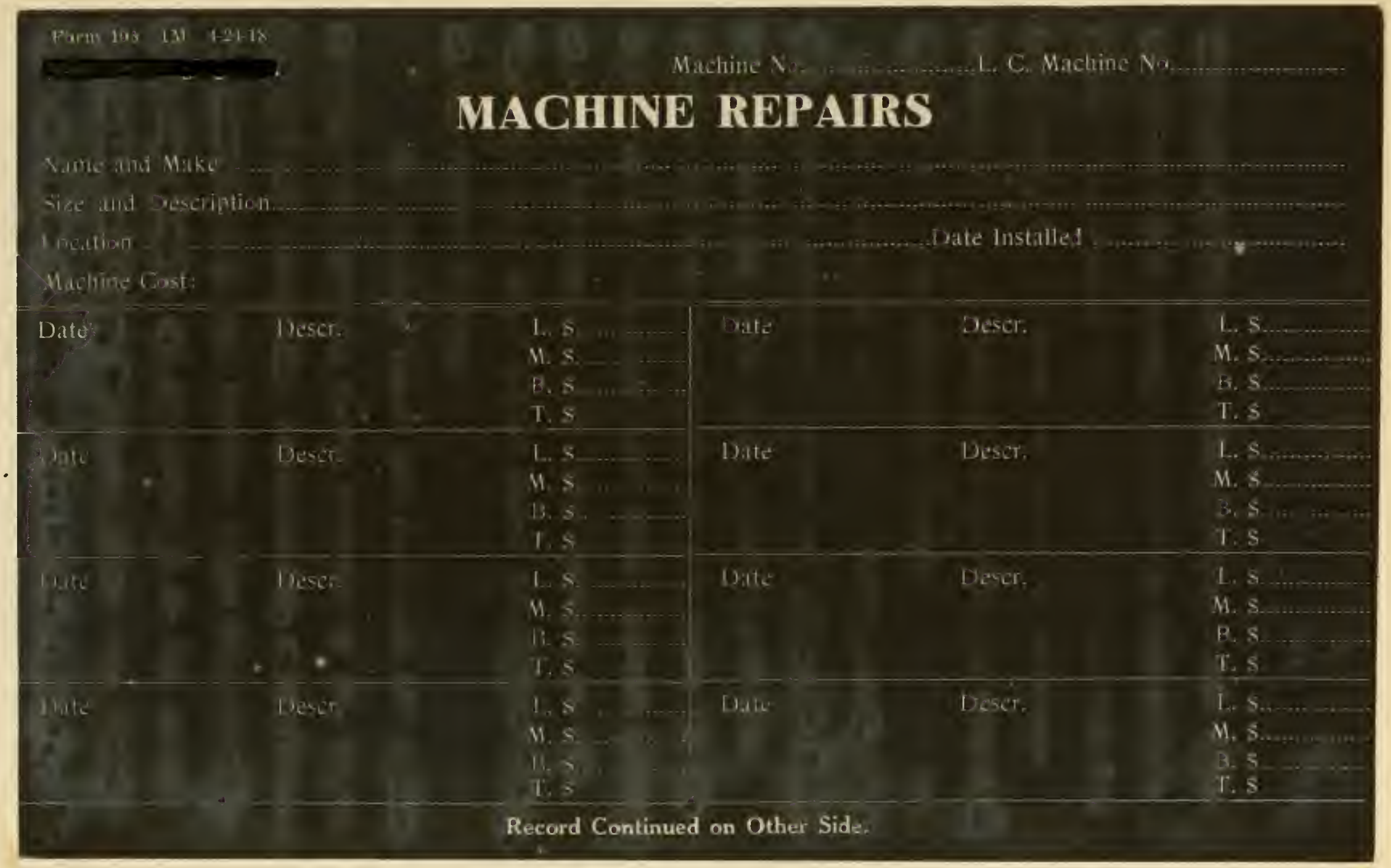
taken as the department floor space. This, as mentioned in Part One, automatically disposes of aisle and other space not occupied by productive machines.

The machine-hours per month are found by going over the time cards turned in by the men, taking off the hours shown on each, and tabulating them on a sheet with vertical columns headed by the machine numbers, on lines numbered to correspond to the days of the month. This is done daily, as soon as the cards can be spared by the time-keeping department, i. e., about two days after being turned in. At the end of the month, the columns are totaled on the adding machine to get machine-hours per machine for the month. The data so obtained is then entered on the "Machine Hour Summary" shown in Figure Two, together with the average kilowatts used, from which the kilowatt-hours used is figured and entered. In starting out with the system, the power required was assumed to be

the same as the rated power, which later will be corrected by making tests of actual power used. The average machine hours and power for each production center or group of machines bearing the same loading class number, was used finding the rate for that group.

The relative amounts of steam, coal, fuel oil, cutting compound, water and air, are found by observation, tests and reports, and the charges for them pro-rated on the basis of relative amount compared with total amount accounted for. The charges are then entered on the "Machine Rate Data" sheet shown in Figure Three, in the proper space.

The expense labor and material are summed up under the running order numbers by the timekeeping and accounting departments, respectively, and submitted to the Loading Rates department. Here the amounts are distributed to the proper production centers, or charged into the items such as steam charge, or electrical charge. The



Form 103 1M 4-24-18

[redacted]

Machine No. .... L. C. Machine No. ....

MACHINE REPAIRS

Name and Make ....

Size and Description ....

Location .... Date Installed ....

Machine Cost:

Date	Descr.	L. $ .... M. $ .... B. $ .... T. $	Date	Descr.	L. $ .... M. $ .... B. $ .... T. $
Date	Descr.	L. $ .... M. $ .... B. $ .... T. $	Date	Descr.	L. $ .... M. $ .... B. $ .... T. $
Date	Descr.	L. $ .... M. $ .... B. $ .... T. $	Date	Descr.	L. $ .... M. $ .... B. $ .... T. $
Date	Descr.	L. $ .... M. $ .... B. $ .... T. $	Date	Descr.	L. $ .... M. $ .... B. $ .... T. $

Record Continued on Other Side.

FIGURE 4.

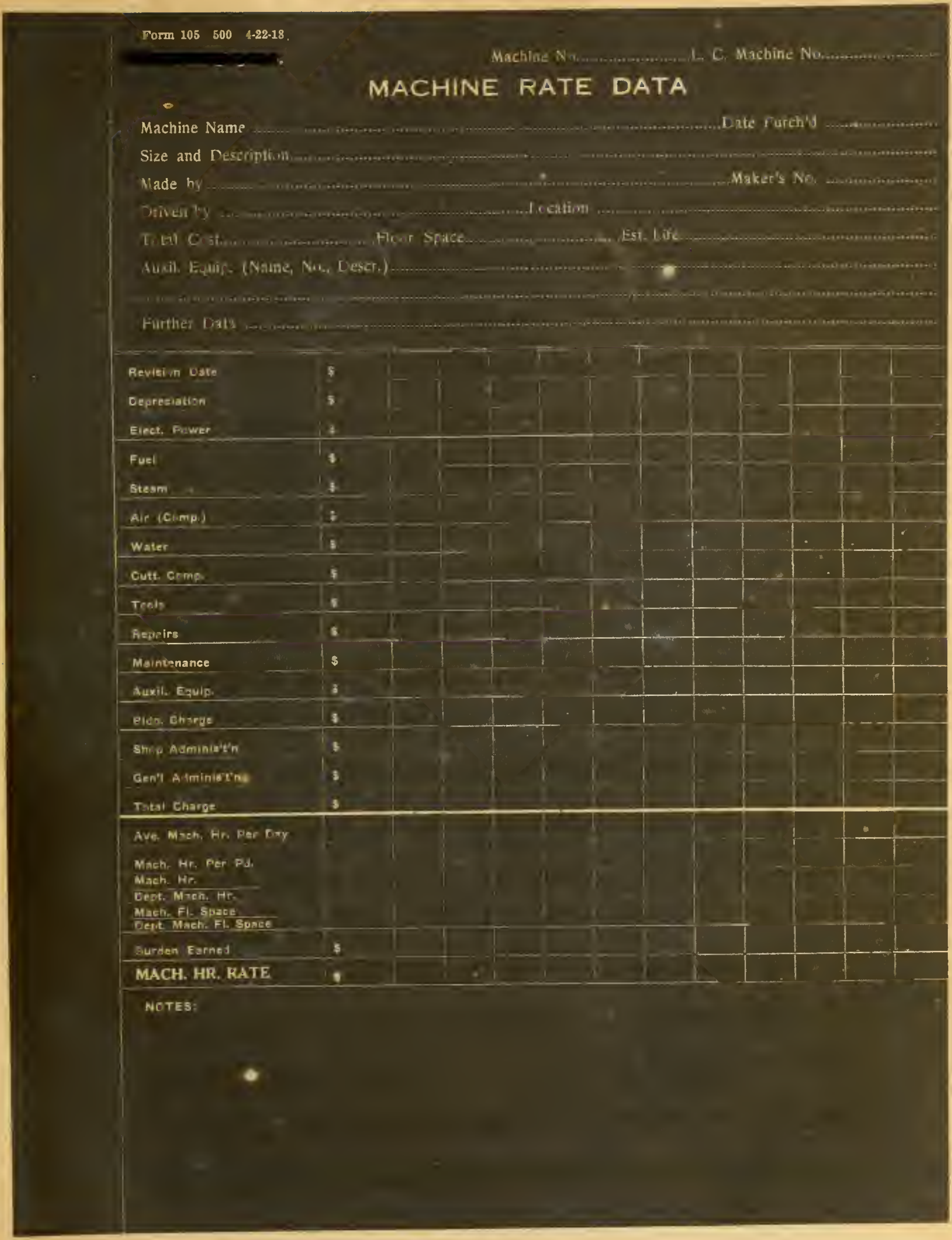
total administrative expense is obtained from accounting and time records, and distributed to the different departments.

The charges for machine repairs are recorded on the "Machine Repair Record" card shown in Figure Four. This is not used in setting the rate, but for record only. The amounts of labor and material involved are determined from time cards and requisitions, and the burden (when work on another productive machine is required) is found from the time cards and machine rate list. These are entered in the proper places, marked L, (labor), M, (material), B, (burden) and T, (total), with a short description of the repair.

The electrical power used is purchased from a power company, and is gotten at a low rate, but by the time the power has reached the machines using it, it has accumulated a number of charges in addition to the power company's bill. The current is delivered to the plant over high

tension wires, passes through transformers and motor generator sets, so that 440 volt alternating, and 220 volt direct current are made available. Thus, in addition to the electrical service department and supplies, there are the charges for the generator house, switchboard, transformers, and distributing system maintenance and depreciation. All these are summed up, which gives the total charge for electrical power delivered to the machines. This amount is then divided by the total kilowatt-hours for the month accounted for by the productive machines, which, gives a power rate to be used in charging them for power.

The steam cost is found from the coal and water used, labor and attendance, maintenance and depreciation, etc., for the boiler house and steam distributing system. The cost as found is used as the basis for determining what amount to add to the rate of the steam hammers for steam used, how much to add to the pumping charges for fuel oil, com-



Form 105 500 4-22-18

[redacted]

Machine No. .... L. C. Machine No. ....

MACHINE RATE DATA

Machine Name .... Date Purch'd ....

Size and Description ....

Made by .... Maker's No. ....

Driven by .... Location ....

Total Cost .... Floor Space .... Est. Life ....

Auxil. Equip. (Name, No., Descr.) ....

....

Further Data ....

Revision Date	$
Depreciation	$
Elect. Power	$
Fuel	$
Steam	$
Air (Comp.)	$
Water	$
Cutt. Comp.	$
Tools	$
Repairs	$
Maintenance	$
Auxil. Equip.	$
Bldg. Charge	$
Shop Adminis't'n	$
Gen'l Adminis't'n	$
Total Charge	$
Ave. Mach. Hr. Per Day	
Mach. Hr. Per Pd. Mach. Hr. Dept. Mach. Hr. Mach. Fl. Space Dept. Mach. Fl. Space	
Burden Earned	$
MACH. HR. RATE	$

NOTES:

FIGURE 3

pressed air (the steam compressors), cutting compound, circulating quenching water for the heat treating department, etc. The other items mentioned are handled in a similar manner, all being analyzed, totals determined, and then distributed either to building charges, or to production centers, as part of the machine hour rate.

After the various costs mentioned are found, the next step is the distribution, which with a few additional items makes up the rate required. The various charges, in the final distribution, are recorded on the "Machine Rate Data" sheet, (Figure 3), one of which is filled out for each production center, regardless of the number of machines in that center. The sheet was designed to apply to all the machines coming under the loading classification, that is, furnaces, anvils, and other equipment performing an operation on productive work, as well as machines as usually meant by that name. There are twelve vertical

columns, one for each month, so each sheet will serve for one year. In addition to cutting down clerical labor, this also furnishes an easy means of comparing the different elements from month to month, which is important, for if any item shows an unusual rise or drop, it indicates a condition requiring investigation. A detailed description of the items on the "Machine Rate Data" form is given in Section 4 of the Factory Instructions.

When the machine-hour rates are determined each month, a list is made up, giving the rate for each production center, and furnished to the cost department. Here, by means of information taken from the time cards, giving the machine number and number of hours it was occupied by the work, knowing the machine rate, the burden is easily figured for each job. The amount charged for direct labor as previously stated, is furnished by the time-keeping department. The material is figured from production reports, giving number of pieces finished, and

number of pieces spoiled, or rejected by the inspection department because of poor steel. Thus the three elements of the factory cost, labor, material and burden are determined, which is the final result wanted.

The following part of this paper is taken from instructions and the machine classification written by the author and issued to those requiring them, in the plant herein discussed.

FACTORY INSTRUCTIONS.

Issued To

ACCOUNTING AND SHOP DEPARTMENTS.

Written by the Author.

INDEX.

1.- Machine numbering system description.
2.- Machine classification lists.
3.- Running order numbers, and instructions.
4.- Machine rate data & instructions.

Note:- In order to provide for the addition of new sheets without disarranging previously numbered pages, the following method will be used in numbering pages:- The page number will be made up of two parts, separated by a decimal point, the figure to the left being the section number as given above in the index, and figure to the right being the page number in that section. Thus 1.4 is page 4 in sedtion 1, the "Machine numbering system description."

MACHINE NUMBERING SYSTEM.

The machine numbering system is designed to perform three functions, (1) to group the machines by functions, types and sizes for ease in applying the machine hour rates, (2) to number the machines for identification purposes, and for ease in locating a machine when its number is known, and (3) to furnish running order numbers for repairs and supplies, which will assist in properly distributing charges and in keeping records.

For the purpose of identification and records, all pieces of equipment are given numbers, in accordance with the general classification for loading purposes, including tanks, pumps, motors, cranes, etc. There will be two general divisions of these numbered pieces,- direct or productive (machines which contribute directly to the product) and indirect or non-productive (machines which do not contribute directly to the product). All productive machines will carry Machine Hour Rates or

loading hourly rates, each class having its rate. The non-productive machines will not carry loading rates, but their charges will be carried by the productive machines. To distinguish between the two classes, the numbers of the non-productive machines will have the prefix "N" before the number, for example N812-5.

For the purpose of cost finding, practically all of the plant equipment except buildings, furniture and fixtures will be considered as machines and assigned numbers. This includes the various piping systems, such as hydraulic piping, live and exhaust steam piping, cutting compound system, etc., line shaft units with their counter shafting and belts, boilers, furnaces and so on, as given in the classification list.

The machine numbers will be made up of two sections, the first section being the loading class number, referred to as L. C. No., and the second the serial number of the machine in that class, the two being separated by a dash (-).

The L. C. No. will consist of three figures, the first, reading from left to right, indicating the functional classification, such as pressure, rotation, drilling and boring, and cutting; the second indicating the type classification, such as steam hammer or forging press, drill press or boring mill, engine lathe or boring lathe; the third indicating the size classification, or a more detailed type classification. These will be referred to as main loading classification, sub-classification and detailed sub-classification, respectively. The prefix "N" will be added where this applies as previously explained. With few exceptions, all productive machines having the same L. C. No. will also have the same loading hourly rate. Machine number means the complete number on a machine, such as 241-8 or 621-4.

In order to properly charge the overhead or loading, it will be necessary that every time card of a man working on a productive mach-

ine carry the machine number, and also state clearly the number of hours that the machine was occupied by the work. This information, together with the hourly rate, will enable the cost department to readily determine the leading charge, which with the direct labor and material make up the manufacturing cost.

The L. C. No. will also be a running order number for each machine for repairs (labor and material) and indirect supplies. The machine number must be given on each order, when for one machine only. In the case of any changes or additions which should be charged to Plant Account, the L. C. No. will not be used, but a different number will be assigned, by the shop clerk, to the order. In the cost accounting department, the running order numbers (which are also the L. C. No's.) will also be the accounting classification numbers, which automatically group the operating and repair charges, and simplify the work of obtaining the loading hourly rates, or

machine hour rate.

Certain parts of the plant equipment which are not strictly machines have been assigned L. C. No's. for the purpose of furnishing running order No's., accounting classification No's., and a means of apportioning certain charges.

MAIN LOADING CLASSIFICATION.

1--Pressure (presses, steam hammers, etc.)

2--Rotation (lathes, etc.)

3--Drilling & Boring (drill press, boring mills, etc.)

4--Shaping (milling machines, shapers, planers, etc.)

5--Heating (furnaces, welding equipment, etc.)

6--Cutting (shears, saws, etc.)

7--Grinding (all grinding equipment.)

8--Fluid handling equipment (pumps, boilers, tanks, accumulators, etc.)

9--Miscellaneous (plant transportation, motors, hoists, blowers, etc.)

SUB-CLASSIFICATION.

1--Pressure.

10- Unclassified.

11- Hammers

12- Hydraulic presses.

13- Hydraulic presses.

14- Punch presses.

15- Hand presses.

16- Sheet metal machines (except shears & punches.)

2--Rotation.

20- Unclassified.

21- Engine lathes (motor drive)

22- Engine lathes (line shaft drive)

23- Engine lathes.

24- Spec. boring lathes.

25- Turret lathes.

26- Special purpose lathes.

27- Miscellaneous lathes.

28- Cutting-off machines.

3--Drilling & Boring.

30- Unclassified.

31- Sensitive feed drill press.

32- Power feed drill press.

33- Radial drill.

34- Boring mills.

4- Shaping.

40- Unclassified.

41- Milling machines.

42- Planers.

43- Shapers.

5- Heating.

  50- Unclassified.
  51- Preheating furnaces.
  52- Billet heating furnaces.
  53- Annealing furnaces.
  54- Heat treating furnaces.
  55- Forges.
  56- Acetylene Welding & Cutting.
  57- Pyrometers.

6--Cutting.

  60- Unclassified.
  61- Shears.
  62- Metal saws.
  63- Saws other than metal.

7- Grinding.

  70- Unclassified.
  71- Floor grinders.
  72- Tool grinders.
  73- Power feed grinders.
  74- Surface grinders (hand feed)

8- Fluid Handling Equipment.

80- Unclassified.

81- Steam pumps.

82- Electric pumps.

83- Air compressors.

84- Blowers.

85- Accumulators.

86- Boilers.

87- Tanks.

88- Feed water heaters.

9--Miscellaneous.

90- Unclassified.

91- Motors (including generators, motor switches & controllers.

92- Electric air & hand hoists & trolleys & monorail system.

93- Electric traveling cranes.

94- Jib cranes (hand and electric) Note:- Hoists on hand cranes are 92-

95- Locomotive & locomotive cranes.

96- Industrial trucks.

97- Hand cars, etc.

98- Conveyor system.

DETAILED SUB-CLASSIFICATION.

1--PRESSURE.

10- Unclassified.

- 101 Forging dies.
- 102 Hammer forging tools (tongs, etc.)
- 103 Press forging tools.
- 104 Car wheel press.
- 105 Tension & compression testing machines.
- 106 Inspection gauges and tools.

11- Hammers.

- 111 Steam drop hammers 18" x 44" to 24" x 44".
- 112 Steam forge hammers 20" x 64" to 24" x 60".
- 113 Steam forge hammers 8" to 16" Bore.
- 114 Steam fracturing hammers.

12- Hydraulic Presses.

- 121 Forging Presses (water pull backs.)- 750 Tons.
- 122 Forging Presses (water pull backs.)- 1200 Tons.
- 123 Forging Presses (steam pull backs.& intensifiers)-1000 Tons.

13- Hydraulic Presses.

131 Straightening press.

132 Small machine shop press.

133 Hydraulic jacks.

14- Punch Presses)power)

141 Trimming presses.

142 Hole punching presses (power)

15- Hand Presses.

151 Forging press (machine shop)

152 Small punching presses (sheet metal)

16- Sheet metal machines (except shears & punches)

161 Break (bending)

162 Sheet roller.

163 Seam & bead rollers.

2--ROTATION.

20- Unclassified.

201 Line shaft units drawing more than one machine, including countershafting, pullies, belts, etc., except belts to machine which are charged to machines.

202 Gauging machines.

203 Centering machines.

204 Bolt & pipe threading machines.

21- Engine Lathes (motor drive.)

211 Under 19" x 10'-0".

212 19" x 10'-0" to 22" x 12'-0".

213 22" x 14" to 26" x 20'-0".

214 27" x 12" to 32" x 20'-0".

215 30" x 22" to 36" x 28'-0".

216 42" x 22" to 42" x 28'-0".

217 48" x 32'-0".

218 60" x 36'-0".

22- Engine Lathes (line-shaft drive)

221 Under 19" x 10'-0".

222 19" x 10'-0" to 32" x 12'-0".

223 22" x 14" to 26" x 20'-0".

224 27" x 12" to 32" x 20'-0".

225 30" x 22" to 36" x 38'-0".

226 42" x 20" to 42" x 22'-0".

227 48" x 32'-0".

23- Engine Lathes (not assigned.)

24- Turret Lathes.

241 Hand screw machine.

242 10" x 60" to 16" x 10'-0" turret lathe (heavy duty)

243 Bullard vertical turret lathes.

25- Special Purpose Lathes.

251 Profiling lathe (reciprocating tool carriage actuated by cam) S.F. Co. make.

252 Bridgeford lathe with S. F. Co. profiling 12" x 20".

253 Amalgamated double tool carriage.

254 30" x 14'-0" Bridgeford double tool carriage (for axles)

255 Center drive axle lathe.

256 Special Boring lathe 26" x 14'-0".

27- Miscellaneous Lathes.

271 Wood turning lathe.

28- Cutting-off Machines.

281 S. F. Co. Axle cutting-off machine.

3--DRILLING & BORING.

30- Unclassified.

301 Drilling tools.

302 Motor drilling machine (chuck or motor shaft.)

31- Sensitive Feed Drill Press.

311 Sipp 12" Overhung.

32- Power Feed Drill Press.

- 321 Baker Bros. Heavy Duty.
- 322 N. B. P. 36".
- 323 Aurora 32".
- 324 Holehog heavy drilling machine.

33- Radial Drill.

- 331 N. B. P. 5'-0".
- 332 Reed Prentice 6'-0".

34- Boring Mills.

- 341 7'-0" Niles.
- 342 48" x 48" Colburn.

4--SHAPING.

40- Unclassified.

- 401 Miller planer & shaper tools.
- 402 Slotter.
- 403 Jointer (wood)

41- Milling Machines.

- 411 Universal miller (motor driven)
- 412 Universal miller (line shaft drive)
- 413 Vertical miller (Becker #6.)
- 414 Heavy duty vertical miller (motor drive)

42- Planers.

421 Under 36" x 36"

422 36" x 36" x 10'-0".

423 42" x 42" x 12'-0".

424 48" x 48" x 10'-0".

425 48" x 48" x 14'-0" and 16'-0".

426 60" x 60" x 26'-0".

43- Shapers.

431 24" - 30" motor driven.

432 24" - 30" line shaft drive.

5--HEATING.

50- Unclassified.

501 Electric furnaces.

502 Gas tempering furnaces.

51- Preheating Furnaces.

511 Oil fired furnaces (doors)

52- Billet Heating Furnaces.

521 Double oil fired 6 door.

522 Continuous, oil fired.

523 Coal fired forging furnaces.

524 Oil fired forging furnaces.

53- Annealing Furnaces.

531 6'-9" x 10'-0" over fired - Car type

532 8'-0" x 12'-0" " " " "

533 Tate-Jones 13'-6" x 24'-0".

54- Heat Treating.

541 Horizontal underfired semi-muffle accurate temperature, 6'-0" x 12'-0".

542 Horizontal Underfired semi-muffle accurate temperature furnace 3'-0" x 6'-0".

543 10'-0" vertical furnace, centrifugal type.

544 15'-0" vertical furnace, centrifugal type.

545 35'-0" vertical furnace, centrifugal type.

546 Small oil fired furnaces.

547 Coolers.

55- Forges.

551 Coal forges.

552 Anvils.

56- Welding.

561 Acetylene generating & distributing system.

562 Welding outfit, including torch (No. of torch.)

6--CUTTING.

60- Unclassified.

601 Wood trimming machine (hand).

61- Shears.

611 Billet shear.

612 Sheet metal straight blades.

613 Sheet metal circle shear.

62- Metal Saws.

621 Peerless high speed hack saw.

622 Racine high speed hack saw.

623 Kwick Kut hack saw.

624 Band saw.

625 Vertical saw (Oliver)

63- Saws other than Metal.

631 Wood band saw.

632 Wood circular saw.

7--GRINDING.

70- Unclassified.

71- Floor Grinders.

711 Direct motor, 2 wheel.

712 Belt drive, 1 and 2 wheel.

72- Tool Grinders.

- 721 Gisholt, (swing tool holder)
- 722 Yankee tool grinder.
- 723 American twist drill grinder.

73- Power Feed.

- 731 Wilmarth & Morman Universal (belt drive)
- 732 Norton universal (belt drive.)

74- Surface Grinders (hand feed).

- 741 Wilmarth & Morman surface grinder.

8--FLUID HANDLING EQUIPMENT.

80- Unclassified.

- 801 Hydraulic high pressure piping system.
- 802 Water piping system (except hydraulic)
- 803 Steam piping system (live & Exhaust)
- 804 Air (Compressed) piping system.
- 805 Fuel oil piping system.
- 806 Cutting compound piping system.
- 807 Quenching oil & water piping system (includes cooling tower).
- 808 Water softener.

Note:- 801 - 806 includes valves, separators; traps, strainers, etc., but end at connection to any equipment bearing another L. C. No.

-1- Steam Pumps.

811	Boiler feed piston rod packed.
812	Boiler feed outside plunger packed.
813	Circulating.
814	Compound low pressure.
815	Oil unloading pumps.
816	Fuel oil high pressure pumps.
817	Vacuum pumps.
818	Hydraulic pumps.

82- Electric Pumps.

821	Hydraulic pumps over 1" water piston drain.
822	Hydraulic pumps 1" or under water piston drain.
823	Triplex water pumps.
824	Motor driven fuel oil pumps.
825	Unlaoding oil pumps.
826	Centrifugal pumps.

83- Air Compressors.

831 Motor driven.

832 Steam driven.

84- Blowers.

841 Blowers requiring 5 H. P. or less.

842 Blowers requiring 5-10 H. P.

843 Blowers requiring 10-25 H. P. (except G. E.)

844 Blowers requiring over 25 H. P. (except G. E.)

845 G. E. Co. high pressure blowers.

85- Accumulators.

851 12" Bore - 5000# Accumulator.

86- Boilers.

861 Coal fired boiler (horizontal tubular)

862 Waste heat boiler (horizontal tubular)

863 Vertical boilers.

87- Tanks.

871 All non-pressure steel tanks.

872 All pressure steel tanks.

873 All concrete tanks 8 vats,

88- Feed Water Heaters.

881 750 H. P. Webster, open heater.

882 500 H. P. Webster, open heater.

9--MISCELLANEOUS

90- Unclassified.

901 Electrical distributing system.

902 Forging conveyor.

903 Billet conveyor.

904 Benches (work)

91- Motors. (Including generators, motor switches and controllers.)

911 10 H. P. or less D. C.

912 10 to 25 H. P. D. C.

913 Over 25 H. P. D. C.

914 10 H. P. or less A. C.

915 10 to 25 H. P. A. C.

916 Over 25 H. P. A. C.

917 D. C. variable speed controllers.

918 A. C. oil switches & starters.

Note:- Above does not apply to traveling crane motors. Knife switches and ordinary D. C. starting boxes will take same No. as motor with "S" added to serial no. i.e 912-83.

92- Electric Air and Hand Hoists & Trolleys & Monorail System.

921 Monorail system.

922 Electric hoists (motor)

923 1 to 5 ton chain hoists.

924 Air hoists.

925 Sifting magnets.

93- Electric Traveling Cranes.

931 Whiting Foundry Equip. Co.

932 Whiting Foundry Equip. Co. with aux. hoists.

94- Jib Cranes.

941 Electric forging cranes.

942 Jib cranes (except elect. forg.) cranes only, hoists not included.

95- Locomotive & Loco. Cranes.

951 R. R. track system in plant.

952 S. F. Co. R. R. locomotive.

953 Locomotive Cranes.

96- Industrial Trucks.

961 Electrical carrying truck (Stor. Batt.)

962 Electric crane truck (Stor. Batt.)

97- Hand Cars, etc.

971 Flanged wheel cars (on rails.)

972 Trailers and trucks.

RUNNING ORDER NUMBERS.

INSTRUCTIONS.

When repair parts, materials for tools, oil, waste and other expense supplies are needed, the requisition will be given a number taken from the list of running order numbers, or if not found there, the L. C. No. on the machine to be supplied. There will be two types of requisitions, (1) for material carried in stock, and (2) for material not carried in stock, and which must be ordered. Requisitions for material carried in stock when properly filled out, i. e. stating purpose of the material, the machine number or L. C. No. on which it will be used, date of issue, the proper running order No. and department, will be honored by the store keeper. Requisitions for material not carried in stock will be made on Form 90 (issued in book form) and forwarded to the store keeper as a notice to obtain the material and a copy will

be retained on file by the department issuing the order, until the material is received. Upon notice that the material is in stock, a requisition made out on Form 17 (issued on 8½" x 4" sheets in tablets) will be presented to the store keeper who will issue the material.

All expense labor performed on shop orders, will be done on job numbers which will be numbered in the same manner as the requisitions for material. Labor such as janitors, watchmen, chip wheelers, etc. will not require shop orders.

As an example of the use of the above, in repairing a boring bar for an Amalgamated lathe, No. XX 241-6, the requisition for the steel used will be numbered XX 241, as will the job ticket on which the labor will be done. In the case of repairs to the steam piping system, the requisitions for material will be numbered 803 (the number which has been assigned to the steam piping system) and the order on which the work is done

will be numbered 803. In order to properly divide the shop expense, it will be necessary that the men working on the various piping systems, on the electrical system, etc. do their work on the proper running job or order numbers as described, drawing their material in the manner described. The running order numbers only apply to repairs and maintenance and not to any work which involves additions to the plant.

RUNNING ORDER NUMBERS.

Note:- Use these numbers where they apply, and when the right number cannot be found in this list, use a number from the machine classification list. The running order numbers only apply to maintenance and repairs and not to any work which involves additions to the plant.

101 - Forging dies, including piercers, tips, etc.

102 - Hammer forging tools.

103 - Press forging tools.

201 - Line shaft units (line shafts, countershafts, pulleys, belts, etc., except belts to machines.

210 - Lathe tools & cutting off tools.

240 - Boring bars and boring lathe tools.

301 - Drilling tools (drills, hollow drills, boring mill tools)

401 - Miller, planer and shaper tools.

510 - Preheating furnaces.

520 - Billet heating furnaces.

530 - Annealing furnaces.

540 - Heat treating.

550 - Forges.

561 - Acetylene generating and distributing system.

620 - Saw blades.

710 - Grinding wheels.

801 - Hydraulic high pressure piping system.

802 - Water piping system, except hydraulic.

803 - Steam piping system (live & exhaust)

804 - Compressed air piping system.

805 - Fuel oil piping system.

806 - Cutting compound system.

807 - Quenching oil and water piping system (includes cooling equip.)

810 - Pumps & accumulators.

860 - Boilers.

901 - Electrical distributing system (includes meters, switchboards, fuses, wiring lights, etc. not carrying other L. C. No., except additions to plant.)

902 - Conveyor system.

903 - Billet conveyors & fracturing equip., except hammers & motors.

904 - Buckets, carrying frames, etc. for handling material & forgings.

910 - Motors, generators, oil switches & D. C. variable speed controllers.

930 - Electric traveling cranes.

940 - Jib cranes.

950 - Locomotive & locomotive cranes and track system.

960 - Industrial trucks (electrical)

970 - Hand trucks & cars.

996 - Inspection and inspection supplies, except tools & gauges (106)

998 - Office supplies (for general factory office, engineering and drafting, time office, laboratory.

999 - Waste, oil, grease and stationary & miscellaneous department supplies not chargeable to another number. (for departments only)

1001 - Building repairs & maintenance.

These numbers are consistent with the general numbering plans and list of the loading classifications (section 2.-) In addition to this list, the machine L. C. No's. will be used as running order numbers, where the charge belongs to a machine, or group.

All requisitions for expense supplies (i. e. supplies not going into the product) must carry a running order number, and all orders for work in connection with repairs, maintenance, replacements for breakage or waar will carry corresponding numbers. These numbers will be assigned by the foreman or his authorized representative from the list given or from the L. C. No. of the machine or group to which the order is chargeable and must show on the time cards of the men doing the work.

It will be necessary that each order or requisition in addition to the number mentioned, give the specific machine or group, number when

possible and the nature of the labor or use of the supplies.

The following description will explain the items coming under the running order numbers and how the charges are apportioned:-

DESCRIPTION OF ITEMS UNDER RUNNING ORDER NUMBERS.

Note:- the running order numbers apply only to repairs and maintenance and not to any work which involves additions to the plant, or additional plant value.

101. Forging Dies. All orders covering labor and material on forging dies will be given number 101, including new dies, repairs to old, adapting old dies to new work, storage and handling charges. The charge under 101 will be apportioned among the hammers and presses as the tool charge. In the case of piercing tips or other supplies or very special dies, which are high in cost, arerapidly used up, and cannot fairly be distributed over the group, their charge will be deducted from the amount which is spread over

the other machines and included in the rates of the machines requiring the special supplies, so that there will be a special rate for these machines.

102. Hammer Forging Tools. Tongs, clamps and other forging tools used on the hammers will be made on requisitions and orders numbered 102. The charges for these will be spread over the hammers.

103. Press Forging Tools. Tongs, clamps and other forging tools used on the presses will be made on requisitions and orders numbered 103. If to be used on one particular press, charge to that press (by machine number) otherwise the charge will be spread over the presses.

201. Line Shaft Units. Line shaft units is taken to mean the line shaft, counter shafts, belts, pulleys, hangers, clutches, belt shifters, in fact everything, except the belts driving the machines, (which are charged to the machines) which are run by one motor, and are used to drive

two or more machines. Countershafts and belting used on one machine only will be charged on orders bearing the L. C. No. of the machine. Includes maintenance and repairs on belts, bearing, etc. This will be charged to the machines in proportion to power used.

210. Lathe Tools. Tools used on engine and turret lathes and hand screw machines. These will be charged as made, the tickets for labor and material being numbered 210. The charge will be divided among the machine mentioned. In case the tools made will be used inter-changeably on lathes, shapers & planers, charge all under 210. This charge will then be apportioned among the classes mentioned.

240. Boring Bars and Boring Lathe Tools. Boring bars; boring heads, cutters. These will be charged as made, under 240, being charged to the proper production center and the charge to each center being spread over the machines in that center.

301. Drilling Tools. This includes drills, boring mill tools, hollow drills for test bars, etc. Charged under 301 as made or purchased, and spread over the drilling machines in proportion to the size of the machine.

401. Miller, plane and shaper tools. Handled same as 210 and 240. Charged under 401 as made or purchased. The charges under numbers 210, 240, 301 and 401 will be distributed over the respective groups as the tool charge. In the case of interchangeable lathe, shaper & planer tools, all charged under 210, a portion of 210 charge will be charged to 401 in proportion to use.

510-550. Furnaces. Expense supplies for all furnaces, (gas, oil, coal, types) and forges (except boiler furnaces) and labor, for repair and maintenance. Fire brick and cast iron furnace doors, burner supplies and other repair parts will be charged as used under the appropriate number, being carried as stores until used.

561. Acetylene Generating and Distributing System. All labor and material in connection with

maintenance and repair of acetylene generator, piping, torches, drums, etc. will be done under 561. Replacements due to wear and breakage will also be charged under 561.

620. Saw Blades, All saw blades such as hack saw blades, band saws, circular saws will be charged under 620 as drawn from stores and used. Charge will be spread over proper production centers.

710. Grinding wheels and supplies. Requisitions for these are to be numbered 710, and the specific machine on which they will be used, specified if possible. This charge will be spread over the grinding machines, both productive and non-productive, the latter going into the department charge.

801 to 807 Incl. The various piping systems including traps, strainers, valves, etc. (pumps not included) have been assigned L. C. No's. for the purpose of determining the charges for the maintenance and repair on each in order to properly apportion these in the costs for water, air, steam, oil,

etc. All labor and supplies such as replacements on piping, broken or damaged fittings, valve-packing, etc. will be done on job tickets numbered according to the system worked on. Supplies are to be charged as drawn from stores. Any new work done such as new pipe lines or extensions, putting in new valves, etc., which are not replacements will not be done on these job numbers, but on a new number assigned by the shop clerk.

810. Pumps and Accumulators. All labor and material used in connection with the maintenance and repair, such as packing, reboring cylinders, replacing worn parts, will be done under No. 810, always giving the specific machine number when possible.

860. Boilers. All material needed or work done on boilers, not regularly performed by the boiler attendant such as rerolling or replacing tubes, relining furnaces, etc. will be done on tickets numbered 860. The specific boiler num-

ber must be given in addition.

901. Electrical Distributing System. (includes meters, switchboards, fuses, wiring, lights, etc. not carrying other L. C. No's.) Repairs, maintenance and replacements to the above will be done on orders numbered 901. (motors under 910.)

902. All labor and material neededfor the maintenance and repair on the shell conveyor will come under 902.

903. Billet conveyors and fracturing equipment, (except hammers and motors) includes all equipment not otherwise provided for, used in connection with the fracturing of shell billets, such as billet handling machines at the fracturing hammers. Repairs and maintenance under 903.

904. Buckets, carrying frames, etc. for handling material and forgings. This includes the boiler shells used as buckets, frames for carrying shell billets, etc., except chains and

hooks, which will be charged to cranes.

910. Motors & Generators, Oil switcches and D. C. Variable Speed Controllers. All maintenance and repairs to motors and generators, oil switches and D. C. controllers will be done under 910. This includes replacements on bearings, brushes and burned out coils, Crane motors will come under 930.

930. Traveling Cranes. Repairs and maintenance on traveling cranes will be done under 930, including motors and controllers, (any repairs on crane runways will come under Building Repairs and Maintenance, 1001.) Includes chains, hooks, etc. and annealing them.

950. All repairs and maintenance on the locomotive, locomotive cranes and track system will be done under 950.

960. Industrial Trucks. (Elect. Storage Battery). Repairs and maintenance on the industrial trucks, such as replacements for worn or broken parts, repairs or replacements on the batteries, motors, etc., will be done under 960.

970. Hand Cars and Trucks. Repairs, replacements and maintenance on the trucks and cars used in transferring forgings about the plant and shops, charged under 970.

996. Inspection & Inspection supplies, except tools and gauges. Includes chalk, paint, flash lights, etc. Inspection labor will also be assembled under 996.

998. Office Supplies. All requisitions for stationery, drafting supplies, printing, etc., used by main factory office , engineering & drafting, time office, employment office, etc., charged to factory administration.

999. Waste, Oil, Grease, Stationary and Miscellaneous department supplies not chargeable to another number. These will be drawn from the store room and charged as drawn. This will be a department charge, distributed on the basis of machine hours.

1001. Building repairs and Maintenance. Covers labor and material coming under that head.

MACHINE RATE DATA.

Note:- The following is an explanation of the items appearing on the "Machine Rate Data" form:

Floor Space. No. of sq. feet of floor space occupied by machine, plus, average space occupied by operator and auxiliary equipment, tool stand, etc.

Auxil. Equip. Auxiliary equipment, i. e., pumps, boilers, blowers, motors not driving main machine, accumulators, valves, hoists, etc. which serve directly the machine in question.

Est. Life. Estimated Life. Life of the machine, during which satisfactory and accurate work may be done without excessive renewals or repairs. Use this as a basis for figuring depreciation.

Note:- As these machines will be used for 20 to 24 hours per day, the actual depreciation will be higher than the standard for machines used on but one shift.

Note:- The following items include the details which contribute to make up the amount of the charge per unit period, as per month or per year, which will have to be carried by the machine in order to pay the indirect expenses incidental to running the business? Machine is taken to mean any equipment used in direct production, such as furnaces, hammers, presses, lathes, etc. Where there is more than one machine of a kind and size, these will be treated as one "machine" or production center, each unit of which will have the same Machine Hour Rate.

Depreciation. Amount charged to operation of machine which will equal cost of machine, less scrap value, at the end of the estimated life of the machine. This item is not to include the auxiliary apparatus which will be taken care of under "Auxil. Equip.).

Elec. Power. All electrical power charged to machine, including machine lights and portion

of total electrical cost including direct power cost, generator house, labor and charges, maintenance of motors including repairs to motors, new brushes, fuses, building lights, electrical department charges. This is not to include power chargeable to auxiliary equipment, which will be taken care of in one sum under item "Auxil. Equip." The total of these costs is to be divided amont the productive machines on the basis of direct electricity consumption compared to direct accounted for shop electricity consumption, i. e., machine watt hours divided by total machine watt hours for the department.

Fuel. Includes direct cost of gas, coal (purchase price, transportation, handling, storage) fuel oil (purchase price, transportation, storage, pumping.)

Steam. Steam which can be directly charged to machine such as steam hammers, hydraulic presses with steam pull backs, steam intensifiers

(steam intensifiers to be considered part of machine). Steam used by heating system to be included in "Bldg. Charge". Steam charge to be based on steam cost, including all items which enter into its production, i. e. fuel, repairs to boilers and furnaces, labor, maintenance, depreciation, on both building and equipment.

Air. Compressed air used which can be charged directly to machine, as on the hydraulic presses with air tool slide. Charge based on steam power cost or electric power cost for pump, plus labor, maintenance, depreciation, housing, etc., divided in proportion to the air used on the machine occupied with the total accounted for, used by producing machines.

Water. High pressure water used by hydraulic presses, soft boiler feed water, quenching and cooling water. Charge includes water purchase cost, pumping charges, cooling charges, softener charges.

Cutt. Compound. Cutting Compound includes direct cost

of renewing compound, and share of pumping-house charge. This is based on fuel, oil, waste and other supplies, labor, depreciation, maintenance and repairs. It is to be divided in proportion to steam used by the pumps, taking the average for the month.

Tools. Cutting-machine Tools., i. e. lathe, planer, shaper, drills, saws, grinding wheels; and presing tools, i. e., punches and dies, hammer dies and anvils, jigs and fixtures. These are to be charged (if made in the tool room) by treating the tool room as a producing department, with machine loading rates, which include the same general charges as the main production sections. As near as possible the machine tool charge will take in the direct tool cost as given by the tool room, though if these are used by different machines and cannot be charged to one particular machine or group, this item will be charged to the department and prorated among the machines in that department.

REPAIRS. Includes repair parts and labor, material and labor on replacements due to wear, packing, belting and all other items which can be charged to repair, and are not charged to some other account.

Maintenance. Includes lubricating oil (total department charge, multiplied by floor space ratio) cotton waste, millwright, pipe fitters, and all maintenance items except pertaining to electrical equipment, which are charged under "Power". Does not include building or indirect equipment charges.

Auxil. Equip. Auxiliary Equipment. As some auxiliary equipment serves several units, this item is a share of charge on this equipment including forging furnaces, boilers (for steam hammers and presses) hydraulic pumps, accumulators, blowers, hoists, acetylene welding equipment, except where used to perform an operation on product, shears, indirect hammers and all equipment not producing a part of the factory product direct-

ly, but serving one machine, or one small distinct unit which does. This charge is to include power, steam, water and air, since for the purpose of finding costs, auxiliary machines and equipment will be treated the same as producing machines and their charges included in the machine hour rate of the main unit or units.

Bldg. Charge. Includes building maintenance, depreciation, repairs on building and indirect equipment, except piping and other items, already provided for, taxes on building and grounds, janitor service, crane service, locomotive and locomotive crane service, inside trucking, heating and ventilating.

Shop Administration. All indirect labor charges, i. e. foreman, assistant foreman, shop clerks, general laborers, etc., including all of shop payroll not on direct production work. This charge is to be determined as one sum for each department. Added to this will be a charge made up of general factory expenses as follows: Salaries for General

superintendent, assistants, engineering department, cost department, time keepers, stores department, paymaster and all other clerks, stenographers, etc. not otherwise charged, which are not chargeable to general administration of the business. The total charge for general factory expense to be pro-rated to the production departments on basis of pay-roll ratio. The department will be apportioned as a period charge among the machines in proportion to the machine hour ratio, and divided later by machine hours for the period.

General Administration. All expenses, except sales, not otherwise accounted for, which can be charged to the operation of the business, includes officer's salaries, clerical help, not chargeable to factory, office rent, taxes other than real estate of works, stationery, etc.. It will be apportioned as a percentage of the burden to be written off by means of the main rate.

Total Charges. Sum of the period charges, under the foregoing items, which will make up the sum of loading or burden to be charged to the machine.

Ave. Mach. Hrs. per day. Average machine hours per day - the number of hours per day the machine will be occupied by the product under normal conditions. This figure will be corrected as necessary to approximate as closely as possible the actual average per day as shown by figures for the preceeding period. However, if the machines are idle for lack of work, the figure taken should not be changed, but should remain the normal number of working and the uneared burden charged to profit and loss, or other appropriate account.

Mach. Hr. per Pd. Machine hours per period, used as basis of computation:- number of hours per period that one machine is occupied by factory product.

$\frac{\text{Mach. Hr.}}{\text{Dept. Mach. Hr.}}$ Machine hours per period divided by the sum of the machine hours in the department.

This ratio will be used in apportioning the total sum of shop administration expense to the machine to be divided later by number of machine hours.

$\frac{\text{Mach. Fl. Space}}{\text{Dept. Fl. Space}}$ Ratio of machine space to sum of machine spaces for department. To be used in apportioning building charges for the machine.

Burden Earned. Product of machine hours for the period and machine hour rate. The sum of these amounts for all the direct machines in a department should equal the total charges against that department as listed above. The degree to which these results agree will determine the adjustment required in the machine hour rates for the next accounting period.

Machine Hour Rate. The total period charge divided by the period machine hours. This is the charge which is to be added to the job cost for each hour the machine is occupied by the work.